CLAIMS

1. A system for improving the movement of material in a vessel, the vessel having an inlet, an outlet, a cylindrical portion having an outer dimension, and a converging transition between the cylindrical portion and the outlet, the system comprising:

means for introducing at least some liquid to the converging transition at a location having a diameter greater than about 75% of the outer dimension of the cylindrical portion of the vessel.

2. The system as recited in claim 1, wherein the means for introducing at least some liquid to the converging transition comprises a diameter greater than about 90 % of the outer dimension of the cylindrical portion of the vessel.

3. The system as recited in claim 1, wherein the cylindrical vessel comprises a circular cylindrical vessel.

4. The system as recited in claim 3, wherein the outer dimension of the circular cylindrical vessel comprises an outer diameter.

5. The system as recited in claim 1, wherein the means for introducing at least some liquid comprises at least one nozzle.

6. The system as recited in claim 5, wherein the means for introducing at least some liquid comprises a plurality of evenly-spaced nozzles.

7. The system as recited in claim 6, wherein the vessel comprises a vessel having a longitudinal axis and wherein the plurality of evenly-spaced nozzles are oriented parallel to the longitudinal axis of the vessel.

8. The system as recited in claim 6, wherein the vessel comprises a vessel having a longitudinal axis and wherein the plurality of evenly-spaced nozzles are oriented at an angle α to the longitudinal axis of the vessel.

9. The system as recited in claim 8, wherein the angle α ranges from about 30 degrees to about 60 degrees.

10. The system as recited in claim 1, wherein the vessel further comprises at least one set of dilution nozzles evenly-spaced about the outlet at a first diameter, and wherein the means for introducing at least some liquid to the converging transition is positioned at a second diameter greater than the first diameter.

11. The system as recited in claim 10, wherein the means for introducing at least some liquid comprises a plurality of evenly-spaced nozzles positioned at a second diameter greater than the first diameter.

12. The system as recited in claim 1, wherein the vessel further comprises at least one baffle plate positioned in the converging transition, and wherein the means for introducing at least some liquid to the converging transition is positioned between the at least one baffle plate and the outlet.

13. The system as recited in claim 12, wherein the means for introducing at least some liquid comprises a plurality of evenly-spaced nozzles.

14. The system as method as recited in claim 1, wherein the cylindrical vessel comprises one of a continuous digester, a batch digester, a washing vessel, a bleaching vessel, a storage vessel, and a retention vessel.

15. A method of treating particulate material in a cylindrical vessel having an interior, an inlet into which particulate material is introduced, and an outlet from which particulate material is discharged, the method comprising:

causing the particulate material to flow in the vessel interior in a substantially vertical flow path;

causing at least some of the particulate material to flow in a non-vertical flow path toward the outlet by providing a converging transition to the outlet; and

introducing a liquid to the converging transition to reduce the resistance to flow of the particulate material through the converging transition to the outlet.

16. The method as recited in claim 15, wherein the vessel comprises a vessel having an outer dimension and wherein introducing a liquid to the converging transition comprises introducing a liquid to the converging transition at a location having a diameter which is greater than about 75% of the outer dimension of the vessel.

17. The method as recited in claim 16, wherein introducing a liquid to the converging transition comprises introducing a liquid to the converging transition at a location having a diameter which is greater than about 90% of the outer dimension of the vessel.

18. The method as recited in claim 15, wherein providing a converging transition comprises providing a dished head having a knuckle, and wherein introducing a liquid to the converging transition comprises introducing a liquid to the knuckle of the dished head.

19. The method as recited in claim 15, wherein providing a converging transition comprises providing a conical transition having a first diameter and a second diameter smaller than the first diameter.

20. The method as recited in claim 19, wherein introducing a liquid to the converging transition comprises introducing a liquid to the vicinity of the second diameter of the conical transition.

21. The method as recited in claim 15, wherein introducing a liquid to the converging transition comprises introducing a liquid to a plurality of nozzles positioned in the converging transition.

22. The method as recited in claim 21, wherein introducing liquid to a plurality of nozzles comprises controlling the flow of liquid through at least one of the plurality of nozzles.

23. The method of claim 15, wherein the particulate material comprises a comminuted cellulosic fibrous material.

24. The method as recited in claim 15, wherein the cylindrical vessel comprises one of a continuous digester, a batch digester, a washing vessel, a bleaching vessel, a storage vessel, and a retention vessel.

25. A digester for treating comminuted cellulosic fibrous material, the digester comprising:

an inlet for introducing comminuted cellulosic fibrous material;

a circular cylindrical portion having an outer diameter;

an outlet for discharging treated comminuted cellulosic fibrous material;

a converging transition between the circular cylindrical portion and the outlet; and

means for introducing at least some liquid to the converging transition at a location having a diameter greater than about 75% of the outer diameter of the circular cylindrical portion of the digester.

26. The digester as recited in claim 25, wherein the means for introducing at least some liquid to the converging transition has a diameter greater than about 90 % of the outer diameter of the circular cylindrical portion of the digester.

27. The digester as recited in claim 25, wherein the means for introducing at least some liquid comprises a plurality of evenly-spaced nozzles.

28. The digester as recited in claim 25, wherein the digester further comprises at least one set of dilution nozzles evenly-spaced about the outlet at a first diameter, and wherein the means for introducing at least some liquid to the converging transition is positioned at a second diameter greater than the first diameter.

29. The digester as recited in claim 28, wherein the means for introducing at least some liquid comprises a plurality of evenly-spaced nozzles positioned at a second diameter.

30. The digester as recited in claim 25, wherein the digester further comprises at least one baffle plate positioned in the converging transition, and wherein the means for introducing at least some liquid to the converging transition is positioned between the at least one baffle plate and the outlet.

31. The digester as recited in claim 30, wherein the means for introducing at least some liquid comprises a plurality of evenly-spaced nozzles.

32. The digester as recited in claim 31, wherein the digester comprises a digester having a longitudinal axis, and wherein the plurality of evenly-spaced nozzles comprise a plurality of evenly-spaced nozzles oriented parallel to the longitudinal axis of the digester.

33. The digester as recited in claim 31, wherein the vessel comprises a vessel having a longitudinal axis and wherein the plurality of evenly-spaced nozzles comprise nozzles oriented at an angle α to the longitudinal axis of the vessel.

34. The digester as recited in claim 33, wherein the angle α comprises an angle which ranges from about 30 degrees to about 60 degrees.

35. A method of treating comminuted cellulosic fibrous material in a digester, the digester having an interior, an inlet for introducing comminuted cellulosic fibrous material, and an outlet for discharging treated comminuted cellulosic fibrous material, the method comprising:

causing the comminuted cellulosic fibrous material to flow in the digester interior in a substantially vertical flow path;

causing at least some of the comminuted cellulosic fibrous material to flow in a non-vertical flow path toward the outlet by providing a converging transition to the outlet; and

introducing a liquid to the converging transition to reduce the resistance to flow of the comminuted cellulosic fibrous material through the converging transition to the outlet.

36. The method as recited in claim 35, wherein the digester comprises a vessel having an outer diameter and wherein introducing a liquid to the converging transition comprises introducing a liquid to the converging transition at a location having a diameter greater than about 75% of the outer diameter of the vessel.

37. The method as recited in claim 36, wherein introducing a liquid to the converging transition comprises introducing a liquid to the converging transition at a location having a diameter greater than about 90% of the outer diameter of the vessel.

38. The method as recited in claim 35, wherein providing a converging transition comprises providing a conical transition having a first diameter and a second diameter smaller than the first diameter.

39. The method as recited in claim 38, wherein introducing a liquid to the converging transition comprises introducing a liquid to the vicinity of the second diameter of the conical transition.

40. The method as recited in claim 39, wherein introducing a liquid to the converging transition comprises introducing a liquid to a plurality of nozzles positioned in the converging transition.

41. The method as recited in claim 40, wherein introducing liquid to a plurality of nozzles comprises controlling the flow of liquid through at least one of the plurality of nozzles.

42. The method of claim 35, wherein the digester comprises one of a continuous digester and a batch digester.

43. The method as recited in claim 35, wherein causing the comminuted cellulosic fibrous material to flow in the digester interior in a substantially vertical flow path comprises causing the comminuted cellulosic fibrous material to flow in the digester interior in a substantially vertical downward flow.

44. The method as recited in claim 35, further comprising forming a zone of compression in the converging transition wherein the particulate material is compressed and resistance to flow is increased.

45. The method as recited in claim 44, wherein introducing a liquid to the converging transition comprises introducing a liquid to the zone of compression in the converging transition.

46. The method as recited in claim 15, further comprising forming a zone of compression in the converging transition wherein the particulate material is compressed and resistance to flow is increased.

47. The method as recited in claim 46, wherein introducing a liquid to the converging transition comprises introducing a liquid to the zone of compression in the converging transition.

48. The system as recited in claim 1, wherein the means for introducing at least some liquid comprises means for controlling the flow of the at least some liquid.

49. The system as recited in claim 2, wherein the means for introducing at least some liquid comprises means for controlling the flow of the at least some liquid.

50. The system as recited in claim 5, wherein the means for introducing at least some liquid comprises means for controlling the flow of the at least some liquid to the at least one nozzle.

51. The system as recited in claim 10, wherein the means for introducing at least some liquid to the converging transition at a second diameter comprises means for controlling the flow of the at least some liquid.

52. The method as recited in claim 19, wherein introducing a liquid to the converging transition comprises introducing a liquid to the vicinity of the first diameter of the conical transition.

53. The method as recited in claim 20, wherein introducing a liquid to the converging transition further comprises introducing a liquid to the vicinity of the first diameter of the conical transition.

54. The digester as recited in claim 25, wherein the means for introducing at least some liquid comprises means for controlling the flow of the at least some liquid.

55. The digester as recited in claim 27, wherein the means for introducing at least some liquid comprises means for controlling the flow of the at least some liquid to the plurality of evenly-spaced nozzles.

56. The system as recited in claim 1, wherein the converging transition comprises an outer surface and wherein the means for introducing at least some liquid comprises means for introducing at least some liquid having a location wherein a line drawn tangent to the outer surface at the location defines an angle φ with the horizontal.

57. The system as recited in claim 56, wherein the angle φ comprises an angle ranging from about 45 degrees to about 75 degrees.

58. The method as recited in claim 15, wherein the converging transition comprises an outer surface and wherein introducing a liquid to the converging transition comprises introducing the liquid at a location wherein a line drawn tangent to the outer surface at the location defines an angle φ with the horizontal.

59. The method as system as recited in claim 58, wherein the angle φ comprises an angle ranging from about 45 degrees to about 75 degrees.

60. The digester as recited in claim 25, wherein the converging transition comprises an outer surface and wherein the means for introducing at least some liquid

comprises means for introducing at least some liquid having a location wherein a line drawn tangent to the outer surface at the location defines an angle φ with the horizontal.

61. The digester as recited in claim 60, wherein the angle φ comprises an angle ranging from about 45 degrees to about 75 degrees.

62. The method as recited in claim 35, wherein the converging transition comprises an outer surface and wherein introducing a liquid to the converging transition comprises introducing the liquid at a location wherein a line drawn tangent to the outer surface at the location defines an angle φ with the horizontal.

63. The method as system as recited in claim 62, wherein the angle φ comprises an angle ranging from about 45 degrees to about 75 degrees.